

WORKING MEMO 71

DATE: June 22, 1977

TO: Bureau Directors

FROM: E.H. Bartsch

SUBJECT: Water - Design - Hydrogen Sulfide Removal

Enclosed you will find a memorandum report from Mr. Douglas M. Caldwell concerning hydrogen sulfide removal from well water. Mr. Caldwell's report is excellent and should be used as a reference when dealing with hydrogen sulfide problems in public water supply systems.

STATE DEPARTMENT OF HEALTH
Lexington, Virginia

Inter-Office Correspondence

TO: Mr. Sutherland

DATE: June 17, 1977

FROM: D. M. Caldwell

SUBJECT: Roanoke County – Water – North Lakes Well No. 5

The following is a summary of my findings regarding hydrogen sulfide removal from well water:

GENERAL: The offensive odor associated with hydrogen sulfide is detectable by the consumer even at low water temperatures at approximately 0.5 mg/l. Concentrations of 0.35 mg/l are only slightly detectable by smell and therefore concentrations of 0.35 mg/l or less cause few people to complain.

SAMPLING

And

ANALYSIS: In collection of samples for hydrogen sulfide analysis, the samples must be taken with a minimum of aeration, for not only is sulfide volatilized by aeration, but also any oxygen which is taken up destroys the sulfide by chemical oxidation. Samples to be used only for total sulfide determination may be preserved by adding zinc acetate solution at the rate of 2 ml. per liter of sample. This precipitates sulfide as inert ZnS, and it also prevents further sulfide generation. Determinations of dissolved sulfide and analyses of samples not preserved, with zinc acetate, must be commenced within three (3) minutes of the time of sampling.

Qualitatively, odors-indicating hydrogen sulfide can be confirmed with lead acetate test paper, which becomes blackened on exposure to the vapor from a slightly acidified sample.

All three forms of sulfide (total sulfide, dissolved sulfide, and un-ionized hydrogen sulfide) may be determined by any of the following methods: (A) titrimetric using iodine, (B) methylene blue color-matching technic, and (C) the methylene blue calorimetric procedure adapted to the use of a spectrophotometer or filter photometer.

HYDROGEN SULFIDE

REMOVAL: The release of pressure and the exposure of high-sulfide well water to the atmosphere are sufficient to remove a portion of the hydrogen sulfide by degasification, while the adsorption of oxygen results in additional removal of the residual gas by oxidation. In waters with a pH of 8 or above, sulfides are relatively soluble, so there is very little free hydrogen sulfide, and consequently no significant odor problems. Below pH 8, alkaline sulfides are converted to hydrogen sulfide gas, which escapes from the water and causes noticeable odors. This pH reduction shifts the ionization constant and as a result of the new equilibrium, a larger percentage of total sulfides is converted to hydrogen sulfide gas which is more readily removed by aeration. It has been shown for one particular well water that at pH values of 5.0, 7.4, and 9.0, 98%, 17%, and 0.5% respectively of total dissolved sulfides exist in the form of undissociated hydrogen sulfide.

Hydrogen sulfide can be removed by aeration, but not completely. Further, the amount removed is not always predictable. Chlorine, when used in sufficient quantities, will oxidize the sulfides to H_2SO_4 ,



but the high chlorine demand makes this treatment alone economically impractical when high concentrations of sulfide are present. Also, if high sulfide concentrations exist, oxidation alone may result in voluminous deposits of elemental sulfur. This problem can be overcome to some degree by: (1) feeding acid to maintain a pH range of 4.0 to 5.0. Therefore, essentially all sulfide would be in a gaseous form and could be removed by degasification; or, (2) removing the sulfides present in the gaseous form by aeration initially followed by chlorination to oxidize the residual sulfides. If it is desired to reduce the sulfides to 0, secondary chlorination is required, regardless of whether aeration alone or a combination of pH reduction and aeration is utilized.

CONCLUSIONS:

This information would indicate that the pH of the source in question and the sulfide concentration present should be the two most important considerations in our review of facilities for hydrogen sulfide removal if the pH of the water under consideration is relatively low, say on the acid side, the literature would indicate that it is not unreasonable to expect approximately 85% sulfide removal by aeration alone. The initial sulfide concentration would determine if pH reduction prior to aeration would be necessary or if aeration alone or aeration followed by chlorination would be satisfactory. The deposition of elemental sulfur would have to be taken into consideration when considering secondary chlorination since excessive sulfur deposits would probably necessitate sedimentation and/or filtration facilities.

Mr. Sutherland
Roanoke County – Water North Lakes Well No. 5
June 17, 1977
Page 3

REFERENCES: Standard Methods For the Examination of Water and Wastewater, Thirteenth Edition, American Public Health Association.

Water and Wastes Engineering, "Removal of iron, Manganese, and Sulfides" by W. A. Wilmarth, August 1968, pg. 52.

AWWA Journal, "Hydrogen Sulfide Problems of Small Water Systems" by Sidney W. Wells, February 1954, pg. 160.

AWWA Journal, "Removal of Hydrogen Sulfide From Well Water" by Sheppard T. Powell and L. G. von Lossberg, December 1948, pg. 1277.

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